

## CLAIMS

I claim:

1. A fluorophosphate glass formed from a composition comprising on a mol basis:
  - a metaphosphate,  $\text{Ba}(\text{PO}_3)_2$ , from 10 to 60 percent;
  - a metaphosphate,  $\text{Al}(\text{PO}_3)_3$ , from 10 to 60 percent;
  - a fluoride,  $\text{BaF}_2$ , from 10 to 75 percent; and
  - a rare earth dopant.
2. A fluorophosphates glass formed from a composition comprising on a mol basis:
  - a metaphosphate,  $\text{Ba}(\text{PO}_3)_2$ , from 10 to 60 percent;
  - a metaphosphate,  $\text{Al}(\text{PO}_3)_3$ , from 10 to 60 percent;
  - a fluoride,  $\text{RF}_n$ , from 10 to 75 percent; and
  - a dopant.
3. The glass as in claim 2 wherein the fluoride is one of the group of:  
 $\text{BaF}_2$ ,  $\text{CaF}_2$ ,  $\text{MgF}_2$ ,  $\text{PbF}_2$  and  $\text{BiF}_3$ .
4. The glass as in claim 2 wherein the dopant is selected from the group of:
  - the rare earth elements neodymium (Nd), erbium (Er), ytterbium (Yb), thulium (Tm), terbium (Tb), holmium (Ho), praseodymium (Pr); an oxide of manganese (Mn); and mixtures thereof.
5. The glass as in claim 4 wherein the dopant is selected from the oxides of the rare earth elements.

6. The glass as in claim 4 wherein the dopant on a mol percent basis is 2 to 15 percent.

7. The glass as in claim 4 wherein the dopant is selected from the fluorides of the rare earth elements.

8. A fluorophosphate glass formed from a composition comprising on a mol basis:

a metaphosphate,  $\text{Ba}(\text{PO}_3)_2$ , from 10 to 60 percent;

a metaphosphate,  $\text{Al}(\text{PO}_3)_3$ , from 10 to 60 percent;

a fluoride,  $\text{BaF}_2$ , from 10 to 75 percent; and

a dopant, from 2 to 15 percent, selected from the group of:

the oxides of the rare earth elements neodymium (Nd), erbium (Er), ytterbium (Yb), thulium (Tm), terbium (Tb), holmium (Ho), praseodymium (Pr);

an oxide of manganese (Mn); and mixtures thereof.

9. A fluorophosphate glass formed from a composition comprising on a mol basis:

a metaphosphate,  $\text{Ba}(\text{PO}_3)_2$ , from 0 to 100 percent;

a metaphosphate,  $\text{Al}(\text{PO}_3)_3$ , from 0 to 100 percent;

a fluoride,  $\text{BaF}_2$ , from 5 to 30 percent; and

a dopant, from 2 to 15 percent, selected from the group of:

the oxides of the rare earth elements neodymium (Nd), erbium (Er), ytterbium (Yb), thulium (Tm), terbium (Tb), holmium (Ho), praseodymium (Pr);

an oxide of manganese (Mn); and mixtures thereof.

10. A fluorophosphate glass formed from a composition comprising on

a mol basis:

a metaphosphate,  $\text{Ba}(\text{PO}_3)_2$ , from 0 to 45 percent;

a metaphosphate,  $\text{Al}(\text{PO}_3)_3$ , from 5 to 30 percent;

a fluoride,  $\text{BaF}_2$ , from 45 to 75 percent; and

a dopant, from 2 to 15 percent, selected from the group of:

the oxides of the rare earth elements neodymium (Nd), erbium (Er), ytterbium (Yb), thulium (Tm), terbium (Tb), holmium (Ho), praseodymium (Pr);

an oxide of manganese (Mn); and mixtures thereof.

11. A fluorophosphate glass formed from a composition comprising on a mol basis:

a metaphosphate,  $\text{Ba}(\text{PO}_3)_2$ , approximately 10 percent;

a metaphosphate,  $\text{Al}(\text{PO}_3)_3$ , approximately 18 percent;

a fluoride,  $\text{BaF}_2$ , approximately 70 percent; and

a dopant, approximately 2 percent:

of the oxide of neodymium (Nd).

12. A fluorophosphate glass formed from a composition comprising on a mol basis:

a metaphosphate,  $\text{Ba}(\text{PO}_3)_2$ , approximately 10 percent;

a metaphosphate,  $\text{Al}(\text{PO}_3)_3$ , approximately 18 percent;

a fluoride,  $\text{BaF}_2$ , approximately 70 percent; and

a dopant, approximately 2 percent:

of the oxide of erbium (Er)..

13. A method for making fluorophosphates glass comprising the steps of:

batching the glass components;

melting the glass components to form a molten mixture;

cooling the molten glass mixture to a solid state;  
annealing the glass in the solid state;  
slowly cooling the annealed glass to approximately ambient temperature;

the glass components comprised on a mol percent basis of  $\text{Ba}(\text{PO}_3)_2$  from 10 to 60 percent;  $\text{Al}(\text{PO}_3)_3$  from 10 to 60 percent; a fluoride selected from the group of  $\text{BaF}_2$ ,  $\text{CaF}_2$ ,  $\text{MgF}_2$ ,  $\text{PbF}_2$  and  $\text{BiF}_3$  from 10 to 75 percent; and a dopant from 2 to 15 percent on a mol percent basis selected from the group of  $\text{Nd}_2\text{O}_3$ ,  $\text{Er}_2\text{O}_3$ ,  $\text{Yb}_2\text{O}_3$ ,  $\text{Tm}_2\text{O}_3$ ,  $\text{Tb}_2\text{O}_3$ ,  $\text{Ho}_2\text{O}_3$ ,  $\text{Pr}_2\text{O}_3$  and  $\text{MnO}$  and mixtures thereof.

14. The method as in claim 13 wherein the melting of the glass is performed in the temperature range of  $1,200^\circ\text{C}$  to  $1,250^\circ\text{C}$  in platinum crucibles in a dry argon atmosphere for from 4 to 5 hours.

15. The method as in claim 13 wherein the annealing of the glass is performed in the temperature range of  $320^\circ\text{C}$  to  $340^\circ\text{C}$  for from 8 to 10 hours.

16. A fluorophosphate glass formed from a composition comprising on a mol basis:

a metaphosphate,  $\text{Ba}(\text{PO}_3)_2$ , from 10 to 60 percent;  
a metaphosphate,  $\text{Al}(\text{PO}_3)_3$ , from 10 to 60 percent;  
a fluoride,  $\text{BaF}_2 + \text{RF}_x$ , from 10 to 90 percent; and  
a dopant.

17. The glass as in claim 16 wherein the fluoride  $\text{RF}_x$  is one of the group of:

$\text{CaF}_2$ ,  $\text{MgF}_2$ ,  $\text{PbF}_2$  and  $\text{BiF}_3$ .

18. The glass as in claim 16 wherein the dopant is selected from the

group of:

the rare earth elements neodymium (Nd), erbium (Er), ytterbium (Yb), thulium (Tm), terbium (Tb), holmium (Ho), samarium (Sm), europium (Eu), praseodymium (Pr); an oxide of manganese (Mn); and mixtures thereof.

19. The glass as in claim 18 wherein the dopant is selected from the oxides of the rare earth elements.

20. The glass as in claim 18 wherein the dopant on a mol percent basis is 2 to 15 percent.

21. The glass as in claim 18 wherein the dopant is selected from the fluorides of the rare earth elements.

22. A fluorophosphate glass formed from a composition comprising on a mol basis:

a metaphosphate,  $\text{Ba}(\text{PO}_3)_2$ , from 5 to 60 percent;

a metaphosphate,  $\text{Al}(\text{PO}_3)_3$ , from 5 to 60 percent;

a fluoride,  $\text{BaF}_2 + \text{RFX}$  selected from the group of  $\text{CaF}_2$ ,  $\text{MgF}_2$ ,  $\text{PbF}_2$  and  $\text{BiF}_3$ , from 10 to 90 percent; and

a dopant, from 2 to 20 percent, selected from the group of:

the oxides of the rare earth elements neodymium (Nd), erbium (Er), ytterbium (Yb), thulium (Tm), terbium (Tb), holmium (Ho), praseodymium (Pr), samarium (Sm), europium (Eu);

an oxide of manganese (Mn); and mixtures thereof.

23. A fluorophosphate glass formed from a composition comprising on a mol basis:

a metaphosphate,  $\text{Ba}(\text{PO}_3)_2$ , from 0 to 100 percent;

a metaphosphate,  $\text{Al}(\text{PO}_3)_3$ , from 0 to 100 percent;

a fluoride,  $\text{BaF}_2 + \text{RFX}$  selected from the group of  $\text{CaF}_2$ ,  $\text{MgF}_2$ ,  $\text{PbF}_2$  and  $\text{BiF}_3$ , from 5 to 90 percent; and

a dopant, from 2 to 20 percent, selected from the group of:

the oxides of the rare earth elements neodymium (Nd), erbium (Er), ytterbium (Yb), thulium (Tm), terbium (Tb), holmium (Ho), praseodymium (Pr), samarium (Sm), europium (Eu);

an oxide of manganese (Mn); and mixtures thereof.

24. A fluorophosphate glass formed from a composition comprising on a mol basis:

a metaphosphate,  $\text{Ba}(\text{PO}_3)_2$ , from 0 to 45 percent;

a metaphosphate,  $\text{Al}(\text{PO}_3)_3$ , from 5 to 30 percent;

a fluoride,  $\text{BaF}_2 + \text{RFX}$  selected from the group of  $\text{CaF}_2$ ,  $\text{MgF}_2$ ,  $\text{PbF}_2$  and  $\text{BiF}_3$ , from 45 to 90 percent; and

a dopant, from 2 to 20 percent, selected from the group of:

the oxides of the rare earth elements neodymium (Nd), erbium (Er), ytterbium (Yb), thulium (Tm), terbium (Tb), holmium (Ho), praseodymium (Pr), samarium (Sm), europium (Eu);

an oxide of manganese (Mn); and mixtures thereof.

25. A fluorophosphate glass formed from a composition comprising on a mol basis:

a metaphosphate,  $\text{Ba}(\text{PO}_3)_2$ , approximately 10 percent;

a metaphosphate,  $\text{Al}(\text{PO}_3)_3$ , approximately 18 percent;

a fluoride,  $\text{BaF}_2 + \text{RFX}$  selected from the group of  $\text{CaF}_2$ ,  $\text{MgF}_2$ ,  $\text{PbF}_2$  and  $\text{BiF}_3$ , approximately 90 percent; and

a dopant, approximately 5 percent:

of the oxide of neodymium (Nd).

26. A fluorophosphate glass formed from a composition comprising on

a mol basis:

- a metaphosphate,  $\text{Ba}(\text{PO}_3)_2$ , approximately 10 percent;
- a metaphosphate,  $\text{Al}(\text{PO}_3)_3$ , approximately 18 percent;
- a fluoride,  $\text{BaF}_2 + \text{RF}_x$  selected from the group of  $\text{CaF}_2$ ,  $\text{MgF}_2$ ,  $\text{PbF}_2$  and  $\text{BiF}_3$ , approximately 90 percent; and
- a dopant, approximately 10 percent:  
of the oxide of erbium (Er).

27. A method for making fluorophosphates glass comprising the steps of:

- batching the glass components;
- melting the glass components to form a molten mixture;
- cooling the molten glass mixture to a solid state;
- annealing the glass in the solid state;
- slowly cooling the annealed glass to approximately ambient temperature;

the glass components comprised on a mol percent basis of  $\text{Ba}(\text{PO}_3)_2$  from 10 to 60 percent;  $\text{Al}(\text{PO}_3)_3$  from 10 to 60 percent; a fluoride of  $\text{BaF}_2 + \text{RF}_x$  where  $\text{RF}_x$  is selected from the group of,  $\text{CaF}_2$ ,  $\text{MgF}_2$ ,  $\text{PbF}_2$  and  $\text{BiF}_3$  from 10 to 90 percent; and a dopant from 2 to 20 percent on a mol percent basis selected from the group of  $\text{Nd}_2\text{O}_3$ ,  $\text{Er}_2\text{O}_3$ ,  $\text{Yb}_2\text{O}_3$ ,  $\text{Tm}_2\text{O}_3$ ,  $\text{Tb}_2\text{O}_3$ ,  $\text{Ho}_2\text{O}_3$ ,  $\text{Pr}_2\text{O}_3$ ,  $\text{Sm}_2\text{O}_3$ ,  $\text{Eu}_2\text{O}_3$  and  $\text{MnO}$  and mixtures thereof.

28. The method as in claim 13 wherein the melting of the glass is performed in the temperature range of  $1,200^\circ\text{C}$  to  $1,250^\circ\text{C}$  in vitreous carbon in a dry argon atmosphere for from 4 to 5 hours.

29. The method as in claim 13 wherein the annealing of the glass is performed in the temperature range of  $320^\circ\text{C}$  to  $340^\circ\text{C}$  for from 8 to 10 hours.